necessary spots and opens up access to the metal layer. In a sixth partial step, the structural transfer into the metal layer is carried out, followed by the removal of the photoresist. The metal layer is now used as a mask for the structuring of the actual glass substrate. The glass substrate is then etched by relatively toxic chemicals. In the last process step, the removal of the metal layer is finally carried out, in most cases in turn by other chemicals.

The necessary process steps for the structuring of such a glass substrate are extremely production-intensive, time-intensive, costly, and, primarily, based on chemicals that are very dangerous and toxic, and immensely harmful to the environment. In addition, a process that is complicated to such an extent with many partial steps is very susceptible to flaws.

In conclusion, it can be stated that in the state of the art, no noteworthy process, most particularly one suitable for mass use, yet exists for the production of monolithic glass substrates, in particular monolithic glass lens wafers, that can be implemented economically, simply, and with as few chemicals as possible.

Embodiments of this invention make available an improved method for the production of optical glass elements.

Disclosure of the Invention

According to a first aspect of the present invention, there is provided a method for the production of an optical glass element, comprising: a) applying a liquid embossing material (4) on an embossing die, b) embossing the embossing material at a temperature of less than 500°C, c) hardening the embossing material, sintering the embossing material and thus executing the primary forming of the optical glass element, wherein the sintering step comprises at least one of a physical and chemical conversion of the embossing material, whereby a reduction of surface roughness of the optical glass element take place during the sintering, and e) removing gases and/or additives generated before and/or during the sintering process, so that a final concentration of the gases and/or additives is lower than 100 ppm, wherein in the step b) structuring of the surface of the glass element is conducted, and wherein in the step d) a reduction of the surface roughness of the glass element is conducted as result of the structuring before the sintering step d).

According to a second aspect of the present invention, there is provided an optical glass element, produced with the above method.

According to the third aspect of the present invention, there is provided a device for implementing the above method.

According to a fourth aspect of the present invention, there is provided a use of the above device for the production of an optical glass element.

All combinations of at least two of the features indicated in the specification, the claims and/or the figures also fall within the scope of the invention. In the indicated ranges of values, values as boundary values that lie within the above-mentioned limits are also to be considered as disclosed and can be claimed in any combination.

Embodiments of the invention relate to a method for the production of an optical glass element, in particular multiple optical glass elements, with the following process sequence:

a) Applying a liquid embossing material on an embossing die, in particular an embossing die surface and/or a substrate of the embossing die,

b) Embossing the embossing material at a temperature of less than 500°C,

CLAIMS

1. A method for the production of an optical glass element (13), comprising:

a) applying a liquid embossing material (4) on an embossing die (1),

b) embossing the embossing material (4) at a temperature of less than 500°C,

c) hardening the embossing material (4),

d) sintering the embossing material (4, 4') and thus executing the primary forming of the optical glass element (13), wherein the sintering step comprises at least one of a physical and chemical conversion of the embossing material, whereby a reduction of surface roughness of the optical glass element (13) take place during the sintering , and

e) removing gases and/or additives generated before and/or during the sintering process, so that a final concentration of the gases and/or additives is lower than 100 ppm,

wherein in the step b) structuring of the surface (6o) of the glass element (13) is conducted, and wherein in the step d) a reduction of the surface roughness of the glass element (13) is conducted as result of the structuring before the sintering step d).

2. The method according to claim 1, wherein the embossing is carried out in step b) at a temperature of less than 400°C, preferably less than 300°C, more preferably less than 200°C, even more preferably less than 100°C, and most preferably at ambient temperature.

3. The method according to one of the preceding claims, wherein after step a), the degree of coverage of an embossing die surface (1o) of the embossing die (1) is more than 20%, preferably more than 40%, more preferably more than 60%, most preferably more than 80%, and with utmost preference 100%.

4. The method according to one of the preceding claims, wherein the embossing material (4) is applied in the form of multiple small, distributed drops on the embossing die (1), in particular on the embossing die surface (1o) of the embossing die (1).

5. The method according to one of the preceding claims, wherein the embossing of the embossing material (4) is carried out in step b) by converging , in particular a lower, embossing die (1) and another, in particular an upper, embossing die (2).

6. The method according to one of the preceding claims, wherein the hardening of the embossing material (4) is carried out in step c) by a thermal method, whereby heat is transported to the embossing material (4), and a polymerization process of the embossing material (4) starts above a critical temperature Tk, the critical temperature being between 0°C and 1,000°C, preferably between 10°C and 750°C, even more preferably between 20°C and 500°C, most preferably between 30°C and 250°C, and all the more preferably between 50°C and 200°C.

7. The method according to one of claims 1 to 5, wherein the hardening of the embossing material (4) is carried out in step c) by an electromagnetic method, whereby the embossing material (4) is irradiated by an electromagnetic radiation, in particular UV light, and the wavelength range of the electromagnetic radiation lies between 1 nm and 10,000 nm, preferably between 10 nm and 1,000 nm, more preferably between 100 nm and 500 nm, and most preferably between 200 nm and 500 nm.

8. The method according to one of the preceding claims, wherein steps a), b) and c) are performed in an embossing device (8), and the sintering is performed in step d) in a sintering device (9) that is separated from the embossing device (8) and arranged preferably outside of the embossing device (8).

9. The method according to one of the preceding claims, wherein the sintering is carried out in step d) by microwave radiation.

10. The method according to one of claims 1 to 8, wherein the sintering is carried out in step d) in a furnace, preferably in a continuous furnace, whereby the temperature during sintering is greater than 50°C, preferably greater than 100°C, more preferably greater than 300°C, even more preferably greater than 500°C, especially preferably greater than 700°C, and most preferably greater than 900°C.

11. The method according to one of the preceding claims, wherein the embossing material (4) has at least one of the following components:

- Polyhedral oligomeric silsesquioxane POSS
- Polydimethylsiloxane PDMS

- Tetraethyl orthosilicate TEOS
- Poly(organo)siloxane silicone

12. An optical glass element (13) produced with a method according to one of the preceding claims.

13. A device for implementing a method according to one of claims 1 to 11.

14. Use of the device according to claim 13 for the production of an optical glass element (13).